LIGHT TREATMENT DEVICE AND METHOD, IMAGING CASSETTE, DOSE MEASURING MODULE AND RADIOLOGY APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of a priority under 35 USC 119 to French Patent Application No. 0004407 filed April 6, 2000, the entire subject matter of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] This invention concerns the treatment of light, in general.

[0003] This invention can be applied in the field of radiology, in which X-ray detection passes through a stage of transformation of X-rays into light that is visible or close to the visible range.

[0004] Patent FR-A-2,753,811 describes a removable digital imaging device to be inserted in a radiology apparatus comprising an X-ray source, a means of maintaining an X-rayed organ and a removable imaging device.

[0005] A mammography apparatus contains an X-ray source, placed on one side of the organ to be X-rayed, a support table transparent to X-rays, placed on the other side of the organ to be X-rayed, an adjustable holding plate that applies the organ on the support table and a housing for receiving an imaging cassette containing a printable film or a digital imaging means.

[0006] A digital imaging cassette comprises a case in which a radiographic signal detection device is placed inside. The device can contain a scintillator capable of transforming X-radiation into luminous radiation, an optical fiber to filter most of the X-radiation having crossed the scintillator and protecting the components situated after the optical fibers, and a matrix camera with charge transfer elements (CCD) forming a sensitive zone.

[0007] However, the images furnished by that type of device are not always of a quality as high as the users might desire.

BRIEF DESCRIPTION OF THE INVENTION

[0008] The invention therefore proposes a light treatment device capable of improving the quality of images obtained from an output.

[0009] A light treatment device, according to one aspect of the invention, comprises a means of filtering the light, so that a first part of the spectrum of the light emitted by a light emitter is preserved, the first part of the spectrum being independent of temperature, and so that a second part of the light spectrum is stopped, the second part of the spectrum presenting a shift dependent on temperature.

[0010] The invention also concerns a radiological imaging cassette containing a light treatment device.

[0011] The invention also concerns a dose measuring module containing a light treatment device.

[0012] The invention also concerns a radiology apparatus containing a radiological imaging cassette equipped with a light treatment device and/or a dose measuring module provided with a light treatment device.

[0013] The invention also concerns a method of treatment of light, in which the light is filtered with a cutoff frequency such that a first part of the spectrum of the light emitted by a light emitter is preserved and a second part of the light spectrum is stopped, the first part of the spectrum being independent of temperature and the second part of the spectrum presenting a shift dependent on temperature.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] An embodiment of the invention is illustrated as follows:

[0015] Figure 1 is a general view in perspective of a radiology apparatus;

[0016] Figure 2 is a schematic view in cross section of the sensitive zone of an imaging cassette;

[0017] Figure 3 is another schematic view in cross section of the sensitive zone of an imaging cassette;

[0018] Figure 4 is a schematic top view in elevation of a dose measuring module; and

[0019] Figure 5 is a curve showing the sensitivity of an X-ray film as a function of wavelength.

DETAILED DESCRIPTION OF THE INVENTION

[0020] It was realized that the temperature of an imaging means capable of transforming the incident radiation of a first wavelength into a radiation of a different wavelength, in the order of that of visible light, for example, could have an undesirable effect on the quality of the image.

[0021] In the case of a dosimeter intended to measure the radiation dose received in a radiology machine and containing an intensifier making it possible to increase the number of photons, while modifying their wavelength, and a photomultiplier making it possible to transform the photons received from the intensifier into electrons for forming an electric signal, it was realized that the characteristics of the intensifier were very sensitive to temperature, notably, the ratio between the number of photons emitted on output and the number of incident photons received on input.

[0022] It was also observed that in a radiological imaging cassette containing an intensifier, the intensifier was very sensitive to the effect of temperature.

[0023] As illustrated on Figure 1, a radiology system comprises a radiology apparatus 1, a puncture system 2, a digital or analog imaging cassette 3 and a control and treatment means. The radiology apparatus 1 comprises a base 5 resting on the floor and supporting a breast-holding plate 6 and an X-ray source 7 which can be tilted in relation

to the vertical plane of symmetry of the radiology apparatus 1. The X-ray source 7 is supported by a column 8.

[0024] The cassette 3 can be inserted by following the direction of the arrow of Figure 1 into a housing of the puncture system 2 or into the housing provided in a cassette holder, not represented, used on diagnostic examinations and intended to be fastened on the breast-holding plate 6.

[0025] As partially illustrated on Figure 2, a cassette 3 contains an upper wall 18 transparent to X-rays, an intensifier 19 capable of transforming the X-rays into visible light and a detection element 20, for example, a matrix camera composed of a plurality of charge transfer cells called CCD or a photosensitive film.

[0026] In operation, the X-rays are emitted by the source 7 (Figure 1), crossing the holding plate of the puncture system 2, the organ X-rayed, the cassette holder and the upper wall 18 of the cassette 3, and pass into the intensifier 19 which, on reception of X-rays, emits the visible light transferred to the detection element 20. A matrix camera can make possible the transformation of information received in the form of visible light into information in the form of a digital electric signal transmitted by the electric cable 13 to the control and treatment means 4.

[0027] In case the detection element 20 is a photosensitive film, no cable is generally provided between the cassette 3 and the treatment means, the cassette is then removed from the housing of the apparatus 1 or from the puncture system 2 for visualization of the image.

[0028] As can be seen, in particular, in Figure 2, the detection element 20 is placed between the upper wall 18 and the intensifier 19 and receives the light emitted by the intensifier 19 on reception of X photons. For example, the intensifier 19 can be made with gadolinium oxysulfite terbium base with a principal light emission peak centered at around 545 nm wavelength. In the case of a photosensitive film, a film presenting a good sensitivity at around 545 nm wavelength may be used. More

generally, it is advisable to use an intensifier and a film which are suitably paired. The film, marketed by KODAK under the name "Min-R 2000", could be suitable.

[0029] In order to avoid the temperature shift encountered on such cassettes, means for filtering is incorporate in the intensifier 19 in the form of mineral pigments. Either organic or mineral pigments can be provided. Those pigments will be such that the photons of wavelengths close to or higher than those of the principal peak of the intensifier 19 are presented and the photons of lower wavelengths are intercepted by the filtering means.

[0030] It was observed that the shift of the ratio between output and input of the intensifier 19, due to temperature, predominantly affected short wavelengths. By filtering the photons of short wavelengths, particularly below 500 nm, and even 400 nm, it is possible to decorrelate the output/input transmission ratio of the intensifier 19 of temperature. That filtering is all the greater as the film is generally sensitive to those short wavelengths.

[0031] In Figure 3 an embodiment of the invention is illustrated, in which means for the filtering the form of a thin layer 21 arranged between the detection element 20 and the intensifier 19. The thin layer 21 can be made with a base of glass, polycarbonate or even acetate loaded with dyes or pigments to filter the part of the light not desired. The means for filtering can also come in the form of a plurality of thin layers for interference filtering.

[0032] In Figure 4 a radiological dose measuring module is illustrated, containing a frame 22 supporting an intensifier 23, a photomultiplier tube 24 and a filter 25. The incident rays, X-rays, for example, arrive in the direction indicated by arrow 26, and are transformed by the intensifier 23 into visible, infrared or ultraviolet light. The light beam emanating from the intensifier 23 is oriented in the direction of arrow 27, crosses the filter 25 and reaches the photomultiplier tube 24, which transforms the photons of the light into electrons generating an electric signal that is emitted by the output represented by arrow 28. The frame 22 forms a guide for the light beam emanating from the intensifier 23.

[0033] In other words, it can be arranged for the walls of the frame 22 to be transparent to the incident radiation arriving on the intensifier 23 and to be opaque to the light beam emitted by the intensifier 23. The filter 25 is mounted, for example, by gluing, soldering, clamping or any other suitable type of connection on the optical path of the light beam between the intensifier 23 and the photomultiplier tube 24. The filter 25 will present a suitable cutoff frequency, generally in the range of visible light, that is, between 400 nm and 800 nm. In particular, a cutoff frequency between 450 nm and 600 nm may be provided and preferably between 480 nm and 540 nm, especially between 500 nm and 530 nm. For example, the filter marketed by GENTEX under the name "Filtron E 520" may be suitable. The intensifier 23 may be made of synthetic material.

[0034] In Figure 5 three curves are illustrated with the wavelength in abscissa. Curve 29 schematically represents the emission spectrum of an intensifier. Curve 30 represents the sensitivity of a photosensitive film. Curve 31 shows the evolution of transmission of an optical fiber. It is to be noted that the intensifier does not emit photons of wavelengths close to 300 nm and an extremely low quantity of photons of 700 nm wavelength, which will not print film whose sensitivity at around 700 nm is nil. On the other hand, it is to be noted that, in this example, the intensifier presents a principal emission peak centered on 545 nm with secondary peaks for lower wavelengths as well as for higher wavelengths. The sensitivity of the film is good for a wavelength close to 545 nm as well as for lower wavelengths to approximately 300 nm. Sensitivity decreases and becomes nil between 600 and 650 nm.

[0035] It has been observed that the temperature shift of the intensifier occurs essentially for the secondary peaks of emissions of wavelengths below the wavelength of the principal peak. A filter is therefore provided, capable of properly transmitting the photons of wavelengths close to those of the principal emission peak of the intensifier and of intercepting the photons of wavelengths corresponding to those of the secondary emission peaks of wavelengths lower than those of the principal emission peak. In this example, an extremely low transmission rate is provided, below 480 nm, and even 450 nm.

[0036] An embodiment of the invention provides a means of light treatment capable of solving the problems presented by the light intensifiers which receive radiation of a certain wavelength and emit luminous radiation of a different wavelength.

[0037] Such means for light treatment are well suited to imaging cassettes, radiological, for example, whether they contain a photosensitive film or a digital light detection means. The means for light treatment is also well suited to modules measuring the radiation dose received.

[0038] In a radiology apparatus those modules can be connected to the control means of the X-ray tube in order to regulate or measure the dose received by the film or the patient. The part of the light sensitive to temperature, that is, whose λ frequency is such that the number of photons of λ frequency is capable of varying as a function of temperature, is simply intercepted before it induces shifts or errors in measurement.

[0039] A cutoff frequency can be determined in order to filter the second part of the spectrum.

[0040] Thus, the photons of such frequency that their number is little sensitive to temperature are preserved and the photons of such frequency that their number is sensitive to temperature are stopped. The light can be obtained from X-rays. The light intensity shift due to temperature is eliminated or at least markedly diminished.

[0041] In one embodiment of the invention, the device is integrated with an intensifier. The intensifier can incorporate mineral or organic pigments.

[0042] In another embodiment of the invention, the device contains means for filtering placed below a light intensifier on the path of the light. The means for filtering may come in the form of a thin film or sheet. The filtering element may be made with a base of glass, polycarbonate, acetate, etc., and be loaded with mineral or organic pigments.

[0043] In an embodiment of the invention, the means for filtering is mounted in contact with the intensifier.

[0044] In an embodiment of the invention, the cassette contains an analog film.

[0045] In another embodiment of the invention, the cassette contains a digital light detector.

[0046] The module advantageously contains a photomultiplier tube, the device being mounted above the photomultiplier tube.

[0047] The module advantageously contains a light intensifier. The module can contain a light guide.

[0048] Various modifications in structure and/or steps and/or function may be made by one skilled in the art without departing from the scope of the invention.